Journal of Autism and Developmental Disorders (2022) 52:938–949
https://doi.org/10.1007/s10803-021-04993-y

ORIGINAL PAPER

A Pilot Randomized Controlled Trial of a Daily Living Skills Intervention for Adolescents with Autism

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Accepted: 29 March 2021 / Published online: 9 April 2021

Abstract

Adolescents with autism spectrum disorder (ASD) without an intellectual disability have daily living skills (DLS) impairments. An initial feasibility pilot of Surviving and Thriving in the Real World (STRW), a group intervention that targets DLS, demonstrated significant improvements. A pilot RCT of STRW was conducted to extend these findings. Twelve adolescents with ASD were randomized to the treatment or waitlist groups. The treatment group had significant DLS improvements on the Vineland Adaptive Behavior Scales, 3rd Edition and the DLS goal attainment scale. Four adolescents from the waitlist crossed over and completed STRW. Entire sample analyses with 10 participants demonstrated large DLS gains. Results provide further evidence of the efficacy of STRW for closing the gap between DLS and chronological age.

Keywords Autism spectrum disorder · Daily living skills · Adolescents · Intervention · Goal attainment scale

While adolescents with autism spectrum disorder (ASD) have core impairments in the areas of social-communication and restricted and repetitive behaviors (American Psychiatric Association, 2013), they also have impairments in their daily living skills (DLS) (Duncan & Bishop, 2015; Kanne et al., 2011; Pugliese et al., 2016). DLS are defined as the everyday activities that one does to take care of themselves, their household, and get around their community. DLS are often categorized into activities in the areas of personal or self-care, domestic or household, and community. For example, adolescents are expected to work toward mastering DLS such as bathing and showering, putting on deodorant, using the stove to cook, cleaning the bathroom, vacuuming and mopping the floor, using a bank account, buying items at the store, evaluating the quality and price of items, setting an alarm to get up on time, and setting short-term and long-term goals. Both the activities and expectations of DLS change over the course of development. For example, the DLS activities of a 3-year-old may include putting toys away, feeding oneself, and toileting with support and prompting from a parent/caregiver, while the DLS activities of a 16-year-old may include independently preparing simple meals, doing laundry, and cleaning one's room. It is anticipated that a 16-year-old will need some assistance when learning new skills (e.g. cooking a new recipe in the oven), but will also require less prompting and guidance from parents as they acquire, practice, and master DLS. Building independence in DLS allows adolescents to then make a smoother transition to going to college, living on their own, and applying for and keeping a job.

Adolescents with ASD who do not have a comorbid intellectual disability (ID) tend to have DLS that are 6–8 years below their chronological age and this "gap" between DLS and chronological age continues to widen over time (Alvares et al., 2020; Bal et al., 2015; Duncan & Bishop, 2015; Kanne et al., 2011; Smith et al., 2012). While neurotypical children and adolescents develop age-appropriate DLS over time, individuals with ASD without an ID appear to have DLS deficits even as young children that continue to become more pronounced over time as they lag behind neurotypical peers in gaining new DLS skills (Kanne et al., 2011).

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Adolescents with ASD without ID may gain DLS over time, but they gain skills at a slower rate and their development of DLS seems to plateau in adulthood (Smith et al., 2012; Szatmari et al., 2009). Several studies have shown that DLS are a predictor of success and long-term outcome in areas such as employment, post-secondary education, independent living, quality of life, and community participation for individuals with ASD without an ID (Dudley et al., 2019; Farley et al., 2009). Thus, it appears that adults with ASD are more likely to have a more optimal outcome in adulthood if they develop the core DLS such as personal care and hygiene, doing laundry, cleaning the house, cooking, managing finances, and navigating within their community (e.g. transportation, grocery shopping, making medical appointments). Despite the importance of these skills, there are no evidence-based intervention packages that target DLS in adolescents with ASD without an ID in order to close the sizable gap between their actual DLS and their chronological age.

Our team has shown preliminary efficacy of a DLS intervention, *Surviving and Thriving in the Real World* (STRW), with a small sample of seven adolescents with ASD and their parents (Duncan et al., 2017). STRW is a manualized intervention that utilizes evidence-based strategies for targeting DLS including behavioral methods and supports (e.g. task analysis, reinforcement, chaining), video modeling, technology, visual supports, direct instruction, and modeling (National Autism Center, 2015; Will et al., 2018; Wong et al., 2015). STRW consists of 15 weekly, 90-min sessions for both adolescents with ASD and their parents that targets the skills of self-care and hygiene, laundry, cooking, kitchen safety, grocery shopping, and money management (see Table 1). The content of STRW was developed for adolescents with ASD in high school (14–21 years), which provides a forum for both parents and teens to discuss the importance of planning for the upcoming transition from high school to the adult world. In the adolescent group, therapists directly teach and model DLS and then have adolescents with ASD practice these skills. Adolescents are also required to complete "real world practice" assignments outside of group (similar to a homework assignment) that help to further build and generalize the DLS that are taught in session. In the parent group, the therapist discusses how to set up a system at home to target DLS through the use of a contract. A portion of each parent session is spent discussing how the contract is being utilized at home and modifying the contract as needed (e.g. specifying the DLS that needs to be completed to earn a specific reward). While the therapist structures the session, the parents in the group provide helpful feedback and tips to each other about how to tackle DLS and also around issues such as managing parental overinvolvement and setting realistic expectations. Parents are also provided with detailed information about what the adolescents are learning in their session. A brief reunification occurs at the end of each session in which parents and teens "check out" with a therapist from the teen group and discuss the upcoming "real world practice" assignment that should be completed before next week's session (see Duncan et al., 2017 for more detailed information about the content and format of STRW).

In our previous single group study, STRW led to increases in DLS in adolescents with ASD. Specifically, participants in a pre-post trial made gains in the Domestic and Community

Table 1 STRW Intervention Sessions

Session	STRW Intervention Content
1	Overview of STRW- build buy-in around why/how to target daily living skills
2	Morning Routine—discuss basic hygiene and self-care activities
3	Morning Routine—develop contract to target individualized morning routine activities
4	Laundry—how to sort clothing and use the washing machine
5	Laundry—how to use the dryer and fold/put clean clothing away
6	Kitchen/Cooking—how to use safe kitchen practices and cook in the microwave
7	Kitchen Cooking—how to mix and measure ingredients and cook in the oven
8	Kitchen/Cooking—how to clean up kitchen messes and cook on the stove
9	Kitchen/Cooking—how to navigate the grocery store, find and purchase items, and put items away at home
10	Coping—discuss basic coping strategies to deal with stress and anxiety
11	Money Management—build understanding of how much items cost and how to purchase items
12	Money Management—understand the purpose of a checking and savings account, how to open a checking account, and how to use a debit card
13	Money Management—understand how to save up for items and create a weekly/monthly budget
14	Money Management—plan a graduation party with a predefined budget
15	Graduation Party—celebrate graduation with a party that was planned by the teens, review progress made, and outline future daily living skills goals

subdomains of the Vineland Adaptive Behavior Scales, 2nd Edition (Sparrow et al., 2005) and made individual gains using goal attainment scaling methodology (Duncan et al., 2017). This pilot also allowed for refinement of the intervention, based on feedback from parents and therapists.

A primary aim of the current study was to evaluate the efficacy of STRW by conducting a small randomized controlled trial (RCT) using a waitlist control group as the previous efficacy study used a single group design. This design allowed us to compare STRW to changes that would naturally occur with the passage of time or due to exposures in the natural environment. After the treatment group completed STRW, the waitlist control group was given the option to cross over and receive the STRW intervention, which allowed for replication of the intervention effect by combining the treatment group with participants from the waitlist control group. Thus, we were able to assess the efficacy of STRW with a larger sample (i.e. 6 participants from the treatment group and 4 participants from the waitlist control group who crossed over and received STRW). Both the treatment group and waitlist control group were followed for 6-months after completing the STRW intervention in order to assess maintenance of treatment gains.

Methods

Participants

Inclusion criteria for the current study included the following: (1) between the ages of 14–21 and enrolled in high school; (2) a diagnosis of ASD based on the Autism Diagnostic Observation Schedule, 2nd Edition and a previous diagnosis of ASD from a medical provider; (3) a full scale IQ ≥ 70; and (4) deficient daily living skills as measured by the Vineland Adaptive Behavior Scales 3rd Edition (Sparrow et al., 2016). Parents of adolescents with ASD were also required to attend the intervention sessions. Exclusion criteria included significant aggressive behavior or mental health issues that warranted treatment outside the scope of the current intervention. The study was approved by the institutional review board for human subjects and informed consent was obtained from both parent and adolescent participants prior to data collection.

Recruitment

Participants were recruited using a variety of methods. First, flyers and emails were sent to families of adolescents with ASD through community organizations, schools, and a family coordinator at an outpatient ASD clinic. Clinicians at an outpatient ASD clinic also referred patients directly to study staff. Lastly, IRB-approved invitation letters were sent to parents of adolescents with a diagnosis of ASD that had been seen for an assessment or treatment in an ASD outpatient clinic or for a research visit at a local children's hospital. The invitation letter included a stamped, return addressed, "Do Not Contact" postcard that families could mail back if they did not want to be contacted about the study. Research staff planned to call all families who had not returned a "Do Not Contact" postcard within 10 days after the invitation letters were mailed. A total of 34 participants either contacted study staff directly to express interest or were contacted by study staff to discuss the study. Of these, approximately 8 participants had scheduling conflicts, 7 participants were not interested, and 4 did not respond to follow-up phone calls. Thus, a total of 15 participants were assessed for eligibility.

Twelve parent-teen dyads met eligibility criteria after completing the baseline assessment. Participants were randomized to the treatment group or waitlist control group using simple randomization. The randomization was conducted using a computer-generated list by an individual independent of the study in order to reduce any potential bias. Six parent-teen dyads were randomized to the treatment group and six parent-teen dyads were randomized to the waitlist control group. All six participants in the treatment group completed the STRW intervention and the post-treatment and 6-month follow-up assessments. After the 15-week period that corresponded with the completion of STRW for the intervention group, all 6 participants in the waitlist control group completed the post-waitlist assessment. In order to provide a treatment replication of STRW, 4 out of 6 participants from the waitlist control group chose to enroll in and complete the STRW intervention and the post-treatment and 6-month follow-up assessments. The 2 participants who did not enroll in the STRW intervention from the waitlist control group declined due to schedule conflicts. Thus, a total of 10 families completed the STRW intervention across the treatment and waitlist control groups (see Table 2 for study participation timeline). Parent participants were compensated $50 for all assessment visits and adolescent participants were compensated $50 for the baseline visit and $25 for all other assessment visits.

Intervention

Surviving and Thriving in the Real World (STRW)

The STRW intervention consisted of 15 weekly, 90-min concurrent parent and adolescent group sessions (see Table 1) that targeted the following skills: (1) Morning Routine (e.g. personal hygiene and self-care skills completed as part of a morning routine); (2) Laundry (e.g. sorting laundry, using the washing machine and dryer, and putting clothes away); (3) Kitchen/Cooking (e.g. kitchen safety, cooking in the microwave, stove, and oven, and grocery shopping; (4) Coping (e.g. utilizing

Table 2 Timeline of Study Participation by RCT Arm

	Time 1	Intervention (15 weeks)	Time 2	Intervention for Waitlist Control (15 weeks)	Time 3	Time 4
Intervention Group	Baseline assessment	STRW intervention	Post-treatment assessment	–	6-month follow-up assessment	–
Waitlist Control Group	Baseline assessment	No intervention	Post-waitlist assessment	STRW intervention	Post-treatment assessment	6-month follow-up assessment

cognitive-behavioral coping strategies to address stress and anxiety); and (5) Money Management (e.g. purchasing items, using a checking/savings account, and budgeting) (see Duncan et al., 2017) for additional information about the initial development and efficacy of the STRW intervention). These DLS were targeted in STRW using evidence-based strategies including video modeling, technology (e.g. phone apps, online games, smart speakers), direct instruction, visual supports, reinforcement, task analysis, and peer and adult modeling. In the adolescent group sessions, a specific DLS was taught and practiced in each session and a "real world practice" assignment was given to lead to further skill acquisition and generalization at home and/or the community (e.g. purchasing items at the grocery store). In the parent group, each session focused on discussing how to target specific DLS and providing feedback to parents on coaching their teen to build these DLS at home and in the community through the use of a contract that specified (1) the target skills (e.g. morning routine); (2) the expectations of each target skill (e.g. complete 7 out of 8 steps of the morning routine each weekday with only 1 verbal prompt); and (3) the reward the teen received for successfully completing target skill (e.g. 10 min of extra screen time). The parent sessions also addressed issues related to parent and teen motivation (e.g. how to individualize rewards for DLS goals, how to make DLS goals functional and doable for both parents and teens) and buy-in from the teen (e.g. how to discuss the rationale for working on DLS goals with teens, how to set expectations for attending group sessions and working on goals at home) as well as any other issues that arose (e.g. sensory aversion to hygiene tasks, fear of using the oven).

Measures

Demographics

Parent participants completed a questionnaire on individual and family information such as race, ethnicity, maternal education, and household income.

Autism Diagnostic Observation Schedule (ADOS-2)

The Autism Diagnostic Observation Schedule, 2nd Edition (ADOS-2; Lord et al., 2012) is a clinician-administered assessment for evaluating autism symptomatology and it was used to verify the diagnosis of ASD at the baseline assessment. All adolescents either received an ADOS-2 Module 4 during the baseline assessment or had a documented ADOS-2 Module 4 administered by a research reliable, certified trainer of the ADOS-2 within 2 years prior to enrolling in the study in their medical record. All participants met criteria for a diagnosis of ASD.

Cognitive Abilities

The Stanford-Binet Intelligence Scales, 5th Edition (Roid, 2003) was used to assess IQ using the abbreviated battery. Participants' cognitive abilities were assessed at the baseline assessment or through a previous research or clinical assessment conducted within the last 2 years as documented in their medical record.

Vineland-Adaptive Behavior Scales, 3nd Edition (Vineland-3)

The Vineland-3 (Sparrow et al., 2016) is the most widely used, gold standard measure of adaptive behavior that measures skills in the domains of Communication, Socialization, and Daily Living Skills (DLS) and is frequently used to assess changes in adaptive behavior for individuals with ASD. The DLS domain consists of the Personal, Domestic, and Community subdomains. On the caregiver rating form, parents rate their child's ability to perform a task independently as *Usually*, *Sometimes*, or *Never*. The Vineland-3 was administered during the baseline assessment to confirm that the adolescent had deficient DLS, which was defined as the DLS domain standard score or one of the three DLS subdomain v-scale scores being 15 points or more below their IQ. Vineland-3 v-scale scores were converted to standard scores when confirming deficient DLS. The Vineland-3 was also used at the post-treatment and 6-month follow-up

assessments. Vineland-3 raw scores on the three DLS subdomains were utilized as a primary outcome measure because they are more sensitive to progress on individual items that were targeted in the 15-week STRW intervention. A recent study with the Vineland-II found that a 5-point change in the DLS Domain score is indicative of a clinically significant change (Chatham et al., 2018).

Daily Living Skills Goal Attainment Scaling (DLS-GAS)

Goal Attainment Scaling (GAS) assesses an individual's progress on a goal in relation to their baseline performance and has been utilized as a more sensitive and accurate measure of outcome in interventions for individuals with ASD (e.g. Pfeiffer et al., 2011; Ruble et al., 2013). Briefly, each goal is developed based on detailed information (e.g. definition of goal, prompting required, etc.) obtained in a parent interview at the baseline assessment and the goal is assessed at the post-treatment and 6-month follow-up assessments (see Duncan et al., 2017 for a detailed description of the DLS-GAS). Goals at baseline are always assigned a score of -2 and are then scored on a 5 point scale (2 to + 2) at post-treatment and 6-month follow-up assessments. Any positive change in score from baseline indicates improvement and a score progression from -2 to 0 indicates the expected level of outcome (i.e. 100% better performance). The current DLS-GAS assessed adolescent's skills in the areas of Morning Routine (11 goal items), Kitchen/Cooking (26 goal items), Laundry (15 goal items), and Money Management (21 goal items). Thus, the Total DLS-GAS consisted of 73 possible goal items, though not all adolescents were assigned all goal items (e.g. had already mastered a skill). A trained research coordinator, who was blinded to the participants' assignment to the treatment or waitlist control groups, conducted the DLS-GAS interview and developed and scored all DLS-GAS goal items at all assessment visits. The therapists facilitating the STRW intervention did not have access to the DLS-GAS.

Acceptability

Parent and adolescent participants completed anonymous acceptability forms to assess how helpful the intervention content (e.g. videos, activities, discussion, coaching) was at the end of each session. Each item was ranked using a 5-point scale from 1 (i.e. not helpful) to 5 (i.e. very helpful). Parents and teens were also asked to provide feedback on what was most helpful, what was least helpful, and any additional comments on each acceptability form.

Treatment Fidelity

All parent sessions were facilitated by the first author and all adolescent sessions were facilitated by psychology postdoctoral fellows and graduate trainees. All sessions were filmed and the first author reviewed all taped adolescent sessions in order to provide supervision. A research coordinator reviewed 25% of all parent and adolescent sessions that were randomly chosen for fidelity. The fidelity sheets consisted of core structural items (e.g. visual schedule, review of previous material) and content items that varied from session to session (e.g. cook scrambled eggs on stovetop, create a task analysis for washing one's hands). The number of items on the fidelity sheets ranged from 5 to 13 depending on the session and directly corresponded to the STRW manual for both parent and adolescent sessions. A rating of 1 was given if the item was covered in the session and a rating of 0 was given if the item was not covered in the session. The mean fidelity ratings for the treatment group were above 95% for the parent sessions (97.2%) and adolescent sessions (95.8%). The mean fidelity ratings for the waitlist control group, after they crossed over into treatment, were at or above 95% for the parent sessions (96.4%) and adolescent sessions (95.0%). Independent sample t-tests revealed that there were no significant differences for fidelity ratings between treatment and control groups for parent sessions ($p = 0.87$) or adolescent sessions ($p = 0.88$).

Analytical Approach

Several analyses were conducted to assess change in DLS as measured by the Vineland-3 DLS domain and three subdomains and the Total DLS-GAS and the four DLS-GAS areas. To evaluate change in DLS from baseline to post-treatment (for the treatment group) and from baseline to post-waitlist (for the control group), repeated measures ANOVAs were conducted. We hypothesized that there would be a significant group (control vs. treatment) by time (baseline vs. post-treatment or post-waitlist) interaction that would allow us to determine if the trajectories of DLS (Vineland-3 and DLS-GAS) were different. Main effects from the ANOVAs were also examined. In order to assess change in DLS for the waitlist control group after they crossed over and completed the STRW intervention, paired-sample t-tests were conducted. Lastly, paired sample t-tests on the entire, combined sample that completed the STRW intervention were conducted to evaluate change in DLS from (1) baseline to post-treatment, (2) baseline to 6-month follow-up, and (3) post-treatment to 6-month follow-up. Statistical significance was defined as $p \leq 0.05$.

Results

Demographic Information

The treatment group and waitlist control group were well matched on all demographic and characterization variables (see Table 3). Adolescents in the waitlist control group did have significantly more restricted and repetitive behaviors as measured by the ADOS-2 ($p = 0.05$).

Table 3 Demographic information and statistical tests of group differences for participants at baseline

	Treatment M(SD) or n	Waitlist Control M(SD) or n	*p* value
Sex			.70
Male	6	5	
Female	0	1	
Age	15.8 (0.9)	15.7 (1.4)	.88
IQ	97.2 (9.6)	94.0 (12.7)	.64
Vineland-3 Standard Scores			
Communication Domain	79.8 (14.8)	79.5 (5.1)	.96
DLS Domain	72.0 (7.7)	70.0 (4.2)	.59
Socialization Domain	69.7 (15.8)	69.8 (6.5)	.98
Adaptive Behavior Composite	73.5 (9.7)	72.7 (3.9)	.85
Vineland-3 DLS Subdomain Raw Scores			
Personal	95.7 (5.5)	93.2 (5.8)	.46
Domestic	29.8 (9.8)	26.2 (6.1)	.46
Community	68.0 (16.2)	68.5 (9.7)	.95
DLS Subdomain	193.5 (29.3)	187.8 (17.7)	.70
ADOS-2			
Social Affect	10.0 (3.3)	11.5 (3.6)	.47
Restricted, Repetitive Behaviors	2.2 (0.8)	3.3 (1.0)	.05
Total	12.2 (3.6)	14.8 (4.4)	.28
Comparison Score	6.5 (2.2)	7.8 (1.5)	.25
Race			.24
White	5	3	
More Than One Race	0	3	
Asian	1	0	
Parent's Income			.59
Less than $36,000	2	0	
$36,000—$65,999	1	0	
$66,000—$99,999	0	4	
Greater than $100,000	3	2	
Maternal Education			.82
High school or less	0	1	
Some college	0	2	
Associate's degree	2	0	
Bachelor's degree	4	1	
Post Bachelor's	0	2	

Attrition and Participation

The attendance rate at sessions for the treatment group was 81.1%, with 66.7% of the parent/teen dyads attending 12 out of the 15 sessions. The attendance rate at sessions for the waitlist control group once they began the STRW intervention was 81.7%, with 75% of the parent/teen dyads attending 12 out of the 15 sessions.

Acceptability

For the entire sample that completed STRW, the mean acceptability rating for the parents was 4.5 and the mean acceptability rating for the teens was 3.4. There was a statistically significant difference between the parent treatment and control groups ($p = 0.009$) such that the control group rated sessions more favorably after crossing over to the STRW intervention than the treatment group. There was also a statistically significant difference between the teen treatment and control groups ($p = 0.03$) such that the treatment group rated sessions more favorably.

The mean acceptability rating for the parents who completed the treatment group was 4.3, and ratings ranged from 3.8 (Session 10—coping with emotions) to 5.0 (Session 14—budgeting and planning for next steps). The mean acceptability rating for the parents from the waitlist control group who enrolled in the STRW intervention was 4.7, and ratings ranged from 4.4 (Session 2—personal hygiene) to 5.0 (Session 8 – cooking on the stovetop).

The mean acceptability rating for the teens who completed the treatment group was 3.6, and ratings ranged from 2.9 (Session 15—graduation party) to 4.1 (Session 6 – cooking in the microwave). The mean acceptability rating for the teens from the waitlist control group who enrolled in the STRW intervention was 3.2, and ratings ranged from 2.4 (Session 6 – cooking in the microwave) to 3.9 (Session 4 – sorting laundry and using the washing machine).

Treatment Group vs. Waitlist Control Group

Vineland-3. The means, standard deviations, and ranges of the raw scores on the Vineland-3 DLS domain and three Vineland-3 DLS subdomains at baseline, post-treatment, post-waitlist, and 6-month follow-up for the treatment group and waitlist control group are presented in Table 4. A 2 (Group: Treatment vs. Waitlist) × 2 (Time: Baseline vs. Post-treatment or Post-waitlist) repeated measures ANOVA of parent report on the Vineland-3 revealed significant interaction effects for the DLS Domain raw score, $F(1,10 = 7.18)$, $p = 0.02$, partial eta squared = 0.42. This suggests that the participants in the STRW treatment group gained significant overall DLS as compared to the waitlist control group. There was also a significant

Table 4 Vineland-3 DLS Domain and Subdomain Raw Scores across All Time Points in the Treatment Group and Waitlist Control Group

	Treatment Group (n = 6)			Waitlist Control Group			
	Baseline	Post-treatment	6-month FU	Baseline (n = 6)	Post-waitlist (n = 6)	Post-treatment (n = 4)	6-month FU (n = 4)
Personal	95.7 (5.5)	98.7 (8.3)	100.8 (4.2)	93.2 (5.8)	86.8 (6.5)	103.0 (2.2)	104.8 (3.0)
Domestic	29.8 (9.8)	39.2 (10.6)	43.3 (12.5)	26.2 (6.1)	29.5 (9.8)	48.8 (7.5)	53.8 (5.6)
Community	68.0 (16.2)	79.5 (20.9)	82.3 (21.9)	68.5 (9.7)	69.8 (10.7)	90.5 (7.0)	96.5 (14.0)
DLS Raw	193.5 (29.3)	217.3 (34.8)	226.5 (33.0)	187.8 (17.7)	186.2 (22.9)	242.3 (15.6)	255.0 (19.9)

interaction effect for the Personal subdomain raw score $F(1,10 = 9.16)$, $p = 0.01$, partial eta squared = 0.48, which suggests that the STRW treatment group gained significant DLS on the Vineland-3 Personal subdomain (e.g. hygiene, healthcare) as compared to the waitlist control group. There were no significant interaction effects for the other Vineland-3 subdomains. However, there was a significant main effect of time for the Domestic subdomain raw score, $F(1,10 = 8.77)$, $p = 0.01$, partial eta squared = 0.47, which suggests both participants in the treatment group and control group had increases in their DLS on the Domestic subdomain.

DLS-GAS

The mean DLS-GAS item score at baseline, post-treatment, post-waitlist, and 6-month follow-up on the Total DLS-GAS and in each of the four targeted areas for the treatment group, waitlist control group, and entire sample are shown in Table 5. A 2 (Group: Treatment vs. Waitlist) × 2 (Time: Baseline vs. Post-treatment or Post-waitlist) repeated measures ANOVA of the DLS-GAS revealed a significant interaction for Morning Routine, $F(1,10 = 5.36)$, $p = 0.04$, partial eta squared = 0.35. These results suggest that participants in the treatment group had significant increases in their individualized hygiene and self-care skills as compared to the waitlist control group. There were no significant interaction effects for the DLS-GAS Total or other DLS-GAS areas.

Table 5 Mean Item Scores on the DLS-GAS

	Treatment Group Mean (SD)	Waitlist Control Group Mean (SD)	Entire Sample Mean (SD)
Baseline	−2.0 (0.0)	−2.0 (0.0)	−2.0 (0.0)
Morning Routine			
Post-Waitlist	–	−1.45 (0.41)	–
Post-Treatment	−0.92 (0.39)	−0.41 (0.70)	−0.71 (0.56)
6-month Follow-up	−0.84 (0.67)	−0.54 (0.65)	−0.72 (0.65)
Kitchen/Cooking			
Post-Waitlist	–	−1.45 (0.34)	–
Post-Treatment	−1.08 (0.42)	−0.62 (0.24)	−0.89 (0.42)
6-month Follow-up	−0.88 (0.48)	−0.26 (0.32)	−0.63 (0.51)
Laundry			
Post-Waitlist	–	−1.43 (0.44)	–
Post-Treatment	−0.81 (0.69)	−0.66 (0.37)	−0.75 (0.56)
6-month Follow-up	−0.64 (0.57)	−0.54 (0.53)	−0.60 (0.52)
Money Management			
Post-Waitlist	–	−1.47 (0.32)	–
Post-Treatment	−1.22 (0.68)	−0.56 (0.38)	−0.96 (0.65)
6-month Follow-up	−0.97 (0.54)	−0.66 (0.41)	−0.85 (0.50)
Total			
Post-Waitlist	–	−1.46 (0.29)	–
Post-Treatment	−1.04 (0.52)	−0.59 (0.28)	−0.86 (-0.48)
6-month Follow-up	−0.86 (0.44)	−0.51 (0.31)	−0.72 (-0.41)

However, there was a significant effect of time in the areas of Kitchen/Cooking, $F(1,10 = 44.19)$, $p < 0.001$, partial et squared = 0.82; Laundry, $F(1,10 = 27.46)$, $p < 0.001$, partial eta squared = 0.73; Money Management, $F(1,10 = 18.33)$, $p = 0.002$, partial et squared = 0.65; and DLS-GAS Total, $F(1,10 = 38.22)$, $p < 0.001$, partial eta squared = 0.79. These results suggest that both participants in the treatment group and control group had increases in their Total DLS-GAS score and in the areas of Kitchen/Cooking, Laundry, and Money Management.

Treatment Replication with Waitlist Control Group

Vineland-3

As shown in Table 4 the paired sample t-tests revealed statistically significant improvement in the raw scores *post-waitlist to post-treatment* for the waitlist control group participants who crossed over to STRW on the DLS domain, $t(3) = -8.78$, $p = 0.003$, d = − 3.49; Personal subdomain, $t(3) = -5.17$, $p = 0.01$, d = − 2.59; Domestic subdomain, $t(3) = -6.94$, $p = 0.006$, d = − 3.47; and Community subdomain, $t(3) = -8.87$, $p = 0.003$, d = − 4.44. These results indicate that the participants made similar gains as those in the treatment group once they completed the STRW intervention. See Fig. 1 for the Vineland-3 DLS subdomain raw scores for both the treatment group and waitlist control group. See Fig. 2 for the Vineland-3 DLS domain raw scores for both the treatment group and waitlist control group.

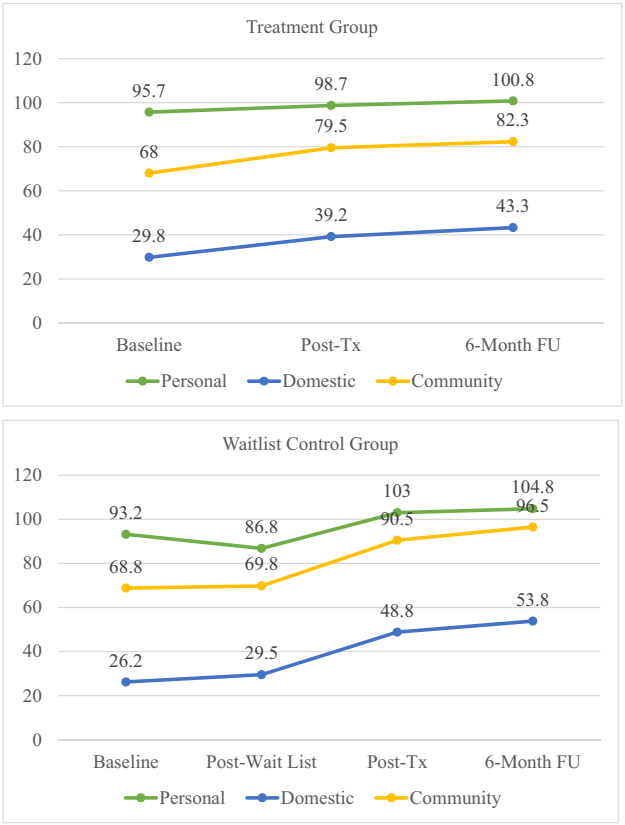

Fig. 1 Change in Raw Scores on the Vineland-3 DLS Subdomains in the Treatment Group and Waitlist Control Group Across all Time Points

DLS-GAS

From *post-waitlist to post-treatment*, paired sample t-tests revealed statistically significant improvement for the waitlist controls who received STRW on the mean item scores for the DLS-GAS Total, $t(3) = -8.72$, $p = 0.003$, d = -4.36; Morning Routine, $t(3) = -3.89$, $p = 0.03$, d = − 1.94; Kitchen Safety, $t(3) = -4.81$, $p = 0.02$, d = − 2.40; Laundry, $t(3) = -5.86$, $p = 0.01$, d = − 2.93; and Money Management, $t(3) = -4.72$, $p = 0.02$, d = − 2.36. This suggests that the waitlist group participants who completed the treatment replication made significant individual gains in all areas measured by the DLS-GAS.

Entire Sample Analyses

Vineland-3

The means, standard deviations, and ranges of the raw scores on the Vineland-3 DLS domain and three Vineland-3 DLS subdomains at baseline, post-treatment, and 6-month follow-up for the entire sample that completed the STRW intervention (n = 10) are presented in Table 6. A paired samples t-test evaluating the change on the Vineland-3 from *baseline to post-treatment* in the entire sample revealed statistically significant results for the DLS domain, $t(9) = -5.48$, $p < 0.001$, d = − 1.73; Personal subdomain, $t(9) = -2.47$, $p = 0.04$, d = − 0.78; Domestic subdomain, $t(9) = -4.88$, $p = 0.001$, d = − 1.54; and Community subdomain, $t(9) = -4.17$, $p = 0.002$, d = − 1.32. These results suggest that when combining the participants who completed STRW into a larger sample, we had increased power that demonstrated that participants made significant increases in all DLS areas that are measured by the Vineland-3 (see also Fig. 3).

A paired samples t-test evaluating the change from *baseline to 6-month follow-up* on the Vineland-3 revealed statistically significant results for the DLS domain, $t(9) = -6.41$, $p < 0.001$, d = − 2.03; Personal subdomain, $t(9) = -4.04$, $p = 0.003$, d = − 1.28; Domestic subdomain, $t(9) = -2.65$, $p = 0.02$, d = − 1.52; and Community subdomain, $t(9) = -5.36$, $p < 0.001$, d = − 1.70. These analyses indicate that increases in DLS were maintained 6 months after the intervention was completed.

A paired samples t-test evaluating the change from *post-treatment to 6-month follow-up* on the Vineland-3 revealed statistically significant differences only on the DLS domain

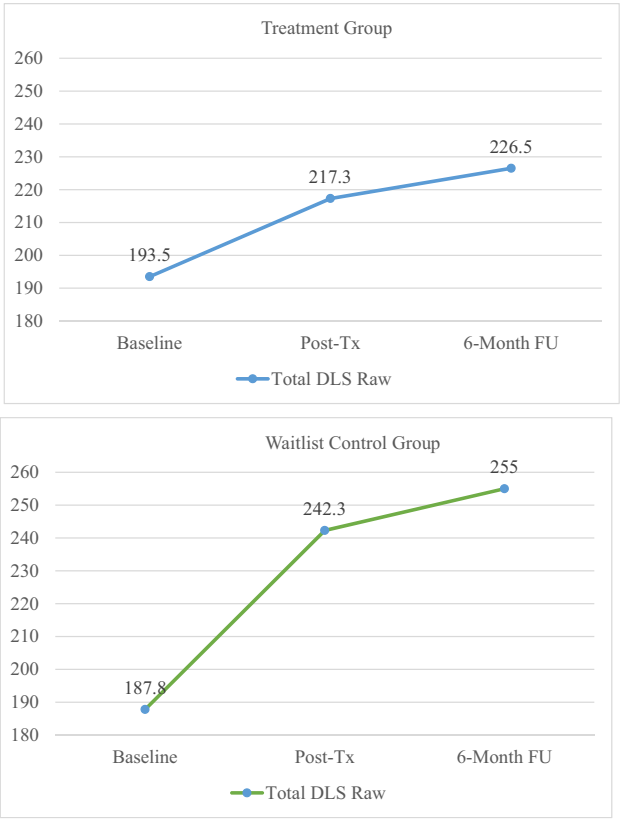

Fig. 2 Change in Raw Scores on the Vineland-3 DLS Domain in the Treatment Group and Waitlist Control Group When Crossed Over to Treatment Across Baseline, Post-Treatment and 6-Month Follow-Up

Table 6 Vineland-3 DLS Domain and Subdomain Raw Scores across All Time Points in the Entire Sample

	Entire Sample (n = 10)		
	Baseline	Post-treatment	6-month FU
Personal	95.5 (5.2)	100.4 (6.7)	102.4 (4.1)
Domestic	29.4 (7.9)	43.0 (10.3)	47.5 (11.2)
Community	69.6 (13.6)	83.9 (17.0)	88.0 (19.6)
DLS Domain	194.5 (23.7)	227.3 (30.3)	237.9 (31.0)

raw score, $t(9) = -2.78$, $p = 0.02$, $d = -0.88$. This indicates that while there were not significant changes in the three Vineland-3 DLS subdomains, there was an increase in overall DLS that suggests maintenance of the skills over time.

DLS-GAS

A paired samples t-test evaluating the change on the DLS-GAS from *baseline to post-treatment* in the entire sample that completed the STRW intervention revealed statistically significant results for the mean item scores for DLS-GAS Total, $t(9) = -7.49$, $p < 0.001$, $d = -2.37$; Morning Routine, $t(9) = -7.22$, $p < 0.001$, $d = -2.28$; Kitchen Safety, $t(9) = -8.37$, $p < 0.001$, $d = -2.65$; Laundry, $t(9) = -7.02$, $p < 0.001$, $d = -2.22$; and Money Management, $t(9) = -5.08$, $p = 0.001$, $d = -1.61$. These results suggest that when combining the participants who completed STRW, we had the power to detect significant individualized increases in all DLS areas as measured by the DLS-GAS.

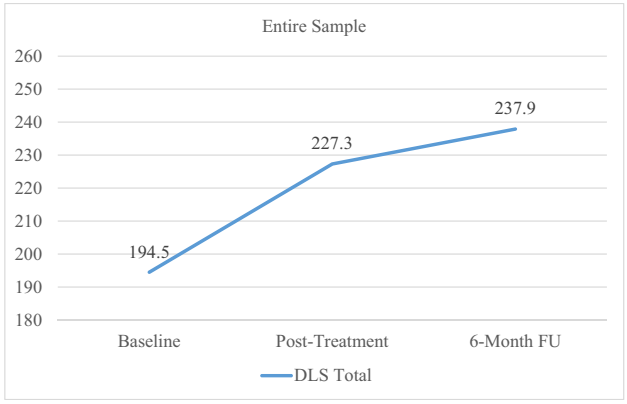

Fig. 3 Change in Raw Scores on the Vineland-3 DLS Domain in the Entire Sample (n = 10)

A paired samples t-test evaluating the change from *baseline to 6-month follow-up* on the DLS-GAS revealed statistically significant results for the mean item scores for DLS-GAS Total, $t(9) = -9.76$, $p < 0.001$, $d = -3.09$; Morning Routine, $t(9) = -6.28$, $p < 0.001$, $d = -1.98$; Kitchen Safety, $t(9) = -8.48$, $p < 0.001$, $d = -2.68$; Laundry, $t(9) = -8.46$, $p < 0.001$, $d = -2.68$; and Money Management, $t(9) = -7.36$, $p < 0.001$, $d = -2.33$. These analyses indicate that increases in DLS were maintained 6 months after the intervention was completed.

A paired samples t-test evaluating the change from *post-treatment to 6-month follow-up* on the DLS-GAS revealed statistically significant differences only on the mean item score for the area of Kitchen/Safety, $t(9) = -3.23$, $p = 0.01$, $d = -1.02$. This suggests that while there were not significant changes in the DLS-GAS Total and the three other DLS-GAS areas, skills related to cooking, cleaning in the kitchen, and kitchen safety were maintained.

Discussion

The current study demonstrated that the Surviving and Thriving in the Real World (STRW) intervention is both feasible and acceptable to both adolescents with ASD and their parents. Specifically, the 10 participants in the entire sample who completed STRW had a mean attendance rate of 81.3% and mean acceptability ratings of 4.51 (with 5 being highly satisfied) for parents and 3.40 for teens.

A primary aim of the current study was to utilize a waitlist control design to examine whether STRW led to improvements in DLS (treatment group) over and above changes in DLS that would naturally occur over time (waitlist control group) as assessed by the Vineland-3 DLS domain and subdomains and the Daily Living Skills Goal Attainment Scaling (DLS-GAS). The STRW treatment group made significant gains on the Vineland-3 DLS domain as compared to the waitlist control, indicating their overall DLS improved following treatment. Further, the treatment group made improvements in the Personal subdomain (e.g. taking a shower, wearing deodorant, taking medications) as compared to the waitlist control group. On the DLS-GAS, participants in the treatment group made significant progress on skills related to their Morning Routine (e.g. waking themselves up, brushing teeth, getting dressed, making breakfast, packing backpack, etc.) as compared to the waitlist control group. Personal hygiene and self-care are the first skills targeted in the STRW intervention as adolescents work on becoming independent in all steps of their morning and/or nighttime hygiene routines. Specifically, parents and adolescents are incorporating it into their contract from Session 3 to Session 15. Hygiene is often the biggest concern for parents such that they are highly motivated to address any skill deficits. While significant progress was not seen in the areas of cooking, laundry, and money management at post-treatment for participants in the STRW intervention as compared to the control group, it may be that these are more complex skills that take several months to practice and master.

Unexpectedly, the treatment group and waitlist group both showed increases in their DLS from baseline to post-treatment or post-waitlist on the Vineland-3 Domestic and Community subdomains and the DLS-GAS areas of Kitchen/Cooking, Laundry, Money Management and DLS-GAS Total. This finding indicates that both groups made progress on these DLS areas across time independent of the treatment group that was receiving an intervention. While it could be that these skills increase as a function of time and exposure, it is also possible that the families who were randomized to the waitlist control group may have been highly motivated to begin treatment and started targeting DLS at home even though they were not yet participating in the intervention. The greater improvement in DLS for the waitlist control group participants who then completed the STRW intervention (discussed below) lends further support to the hypothesis that these may have been families who were highly motivated to address DLS.

The above findings were replicated and extended when the waitlist control group crossed over to complete the STRW intervention. Specifically, the waitlist control group made significant gains from post-waitlist to post-treatment on the Vineland-3 DLS domain, the three Vineland-3 DLS subdomains, the DLS-GAS Total, and the four DLS-GAS areas. The waitlist control group appeared to make significant and rapid progress from post-waitlist to post-treatment (see Figs. 1 and 2), which builds on the hypothesis that this may have been a highly motivated group of parents and adolescents.

When we combined the treatment and waitlist control group participants in order to explore the effects of the STRW intervention in a larger sample (n = 10), with the additional power of a larger sample size, statistically significant gains were found baseline to post-treatment on the Vineland-3 DLS domain, all three DLS subdomains, Total DLS-GAS, and all four areas assessed by the DLS-GAS (Morning Routine, Laundry, Kitchen/Cooking, and Money Management) from both baseline to post-treatment and baseline to 6-month follow-up. It is especially encouraging that the teens made such improvements on the Vineland-3. Notably, the mean DLS domain standard score increased 72.2 to 87.5 from baseline to 6-month follow-up. This 15-point gain moved teens into the "average range" on the Vineland-3 DLS domain. The improvements in DLS as a result of participating in STRW are further illustrated by examining changes in age-equivalent scores. The teens gained an average of 5.5 years in the Personal subdomain, 7.3 years in the Domestic subdomain, and 4.3 years in the Community subdomain from baseline to 6-month follow-up. Thus, many teens were able to close the gap between their DLS and their chronological age such that they have acquired and mastered DLS that are similar to their same-aged peers.

Interestingly, the participants in the waitlist control group appeared to make substantial progress after completing the STRW intervention such that they drove some of the significant results in the entire sample group. In examining the Vineland-3 results (see Figs. 1 and 2) from post-waitlist to post-treatment, the waitlist control group appears to have a steeper slope as compared to the treatment group (i.e. on the Domestic and Community subdomains and the DLS domain). However, it is important to note that only 4 participants were in the control group, so these results need to be interpreted cautiously. The treatment group and waitlist control group were not significantly different from one another at baseline, but it is possible that several factors may explain why the waitlist control group demonstrated such large DLS gains after completing STRW. One possibility is that the waitlist control group parents were highly motivated and had increased engagement once the STRW intervention began because they had already waited over 6 months to receive the treatment. Another possibility is that they received more time and attention due to smaller group size (4 parent/teen dyads vs. 6 parent/teen dyads), which allowed for more individualization on how to target DLS at home and in the community in the parent group and more direct instruction and practice of DLS in the adolescent

group. Due to the smaller group size, parents in the control group may have also felt more accountability around targeting goals with their adolescent because they would have to report back to a smaller group of parents and therapist who would then help with identifying potential barriers.

While adolescent participants maintained DLS from post-treatment to 6-month follow-up, they did not continue to show the rapid and pronounced DLS improvements made from baseline to post-treatment. This speaks to the need for individual or group check-ins after the completion of STRW to discuss what DLS are being worked on and how they are being targeted and to also troubleshoot any issues related to adolescent motivation. For example, families who have completed STRW have indicated that they would be interested in a monthly or quarterly booster session in which a previously taught skill or new skill is discussed with adolescents (e.g. cooking a complete meal, nutrition and healthy eating, using public transportation, cleaning one's room, cleaning a bathroom, etc.), and then parents discuss how to work on incorporating new DLS into their contract and how to fade back rewards, generalize skills to other environments, etc.

Several refinements and modifications were made to the STRW intervention that will be used in future studies as result of the formal and informal feedback provided from parents, teens, and therapists. On the acceptability forms, parents indicated that they did not feel the session on coping with emotions and managing stress was a necessary component for the STRW intervention and noted that it got them "off track" from working on the DLS on their contract. While parents stated that it was beneficial to have a brief overview of useful coping strategies, many thought that more sessions were needed to fully address this and that it took away from the content specific to DLS. We made several other changes to the STRW intervention based on parent and teen feedback including: (1) adding in *Price is Right*© games for each session to increase understanding of what things cost; (2) adding in an online quiz app to review content taught in the previous session; (3) adding in several interactive group activities for the money management sessions to increase engagement; (4) adapting recipes used in cooking for teens with allergies and/or food preferences; and (5) increasing use of video clips to teach or illustrate core concepts. The modifications described above have been made and are being used in a current study that is assessing the efficacy of STRW (both in-person and telehealth) as compared to a social skills intervention in a large RCT.

Limitations

The current study has several limitations. First, the sample size was small, even when combining the treatment group and waitlist control group. While the current study was an attempt to further establish preliminary efficacy using a waitlist control design to inform a larger trial, we did not correct for multiple analyses, which may lead to an increased likelihood of Type I error. Additional research with a larger, more diverse group (e.g. race, gender, socioeconomic status) of adolescents with ASD is needed. Second, the primary outcome measures that assessed DLS were both based on parent report. The parents who completed the outcome measures were also participants and were aware of whether they received STRW, the waitlist control group, or crossed over to complete STRW after the waitlist control. The majority of DLS assessments are parent-report, but it is critical to also obtain information from adolescents with ASD or obtain a direct behavioral measure of DLS.

Future Directions

Our team is currently conducting a large randomized controlled trial with adolescents with ASD that is comparing STRW to an evidence-based social skills intervention (i.e. PEERS—Laugeson et al., 2012) that is identical in terms of session frequency, duration, and format (i.e. separate parent and teen groups). A larger RCT will allow us to examine how a range of individual and family variables (e.g. socioeconomic status, family size, parenting style, race and ethnicity) may influence DLS gains. The STRW intervention being tested in the large RCT was refined based on parent feedback from the current study. Lastly, our team is utilizing both parent report and self-report to assess the DLS of adolescents with ASD. We are also utilizing novel outcome measures including daily phone diaries to record the behaviors of both adolescents and their parents with ASD over a 24-h period, and we have developed a DLS behavior observation measure to get a direct assessment of cooking, laundry, and money skills.

Conclusion

Overall, the STRW intervention demonstrates efficacy and shows promise as a treatment that can lead to successful acquisition and mastery of DLS in adolescents with ASD. Adolescents made significant gains after completing the STRW intervention and several adolescents closed the gap that had existed between their chronological age and DLS. Future research on STRW is needed to determine its efficacy at building critical DLS that may then lead to more successful outcomes in independent living, employment, and community participation for adolescents with ASD without an ID.

Author Contributions Conceptualization were performed by Dr. D, Dr. S and Dr. R. The Data Curation Were Performed by Dr. D and Dr.

F. The Formal analysis Were Performed by Dr. D, Dr. MD and Dr. S. Investigation Were Performed by Dr. D. The Methodology Were Performed by Dr. D, Dr. S, Dr. R and Dr. MD. The Writing– original draft Were Performed by Dr. D. The Writing – review and editing Were Performed by Dr. D, Dr. MD, Dr. R, Dr. F

Funding This study was funded by Eunice Kennedy Shriver National Institute of Child Health and Human Development with Grant No. K23 HD094855-01A1 and U.S. Department of Defense Grant No. W81XWH-18-1-0677.

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